EXHIBITES

623.20.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section		
Type III Epoxy	1039		
Sand for Mortar	1039		

# 623.20.3 Construction Requirements.

- 623.20.3.1 Surface Preparation. The surfaces to which the epoxy mortar is to be applied shall be free of dust, water or any other material that may affect the adhesion.
- 623.20.3.2 Application. The epaxy mortar shall be prepared and placed when the weather is dry and the air temperature is in accordance with the manufacturer's written recommendations.
- 623.20.3.2.1 The contractor shall mix only the number of containers of material that can be placed in 20 to 40 minutes.
- 623.20.3.2.2 Epoxy shall be thoroughly mixed in accordance with the manufacturer's written recommendations. Mixing shall continue as permitted to ensure uniformity.
- 623,20.3.2.3 When the epoxy material has been thoroughly mixed, sand shall be added at the manufacturer's recommended rate while mixing continues. After the proper quantity of sand has been added, mixing shall continue until the mixture is uniform
- 623.20.3.2.4 Argas to be patched or leveled shall be thoroughly primed with an application of neat epoxy. After the area is primed, the mortar shall be placed and struck off to grade. The surface shall have a rough finish equal to that of a Portland cement concrete teck.
- 623.20.3.2.5 The patched or leveled area shall be protected during the curing period to provent damage. Material shall be cured in accordance with the manufacturer's written ecommendations. Curing acceleration by direct flame application will not be permitted.
- 623.20.4 Basis of Payment. No direct payment will be made for furnishing material, surface preparation or application.

# SECTION 623.30 EPOXY POLYMER CONCRETE OVERLAY.

- **623.30.1** Description. This work shall consist of furnishing and applying thin polymer concrete overlays in a prime coat, plus two courses on designated bridge structures as shown on the plans or as directed by the engineer.
- 623.30.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Epoxy Resin for Epoxy Polymer Concrete Overlay	1039
Aggregate for Epoxy Polymer Concrete Overlay	1039

# 623.30.3 Construction Requirements.

**623.30.3.1** Manufacturer Representation. The overlay manufacturer's representative shall witness the entire testing phase of each field test. The manufacturer's representative shall verify that all operations are performed by acceptable practices.

- 623.30.3.2 Handling and Storage of Material. Handling and storage of material shall be in accordance with the manufacturer's written recommendations.
- 623.30.3.3 Field Test. Prior to the start of the overlay operation, a test area of the complete overlay system shall be placed on the bridge deck in a contractor proposed location that is approved by the engineer. When multiple bridges are included in a project, a test area will be required on each bridge. The contractor may utilize one-half of the bridge deck or an area equal to one day's placement operation, whichever is smaller, as a field test. The degree of cleaning used on the test area shall be the minimum used on the remainder of the structure. The surface for the test overlay shall be prepared in accordance with the test method prescribed in ACI 503R Appendix A of the ACI Manual of Concrete Practice to establish an approved cleaning practice.
- 623.30.3.3.1 The approved cleaning practice shall remove all potentially detrimental material which may interfere with the bonding or curing of the overlay. Concrete shall be sound, with mortar soundly bonded to the coarse aggregate, with clean and open pores to be considered adequate for bond. Areas of asphalt that are larger than one inch (25 mm) shall be removed. Areas of asphalt that are smaller than one inch (25 mm), but are spaced less than 6 inches (150 mm) apart shall also be removed. Pavement marking will be considered clean when the concrete has exposed aggregate showing through at least 75 percent of the pavement marking.
- 623.30.3.3.2 In addition to the above requirements, the cleaning practice shall provide an adhesion strength test result greater than 250 psi (1.7 MPa) or a failure area into the base concrete that is greater than 50 percent of the test area. After the test area has cured for a minimum of 72 hours, adhesion shall be checked in accordance with ACI 503R. A test result will be the average of three tests on a sample area of the test patch. A minimum of three sample areas per test patch shall be tested. Successful test results will be required from each sample area.
- 623.30.3.3.3 If the test of a sample area fails to meet the above requirements due to a cohesive failure of the substrate concrete, the adhesive strength of the sample area will be considered acceptable.
- 623.30.3.3.4 Successful completion of the adhesion strength tests will be required before the full-scale overlay operation is to begin. All cleaning operations shall equal those used for the adhesion strength test areas, in both profile and cleanliness. If changes are made to the established cleaning practice, new adhesion strength testing shall be performed at the contractor's expense.
- 623.30.3.3.5 Test patches shall be installed with the same material, equipment, personnel, timing, sequence of operations and curing period that will be used for the installation of the overlay.
- 623.30.3.3.6 If the test fails, the contractor shall remove the material represented by the failed test patches and provide another test patch, at the contractor's expense, until satisfactory test results are obtained.
- **623.30.3.4** Surface Preparation. Before placement of the overlay, the entire deck surface shall be prepared by the cleaning practice established in the field adhesion strength tests in accordance with Sec 623.30.3.3.
- 623.30.3.4.1 If the engineer determines that the weather has changed significantly since the application of the field test patch, the contractor shall verify through adhesion strength tests that the practice is acceptable, at the contractor's expense.

- **623.30.3.4.2** No traffic of any kind shall be permitted on any portion of the deck which has been shot blasted or on the overlay without approval from the engineer. The time between surface preparation and application of the first course shall not exceed 24 hours.
- 623.30.3.4.3 All patching and cleaning operations shall be inspected and approved prior to placing the overlay.
- 623.30.3.4.4 If the deck or intermediate course is contaminated by foreign material or water after initial cleaning, the contamination and any detrimentally affected overlay material shall be removed. Both courses shall be applied prior to opening the area to traffic.
- 623.30.3.5 Equipment. The contractor's equipment shall be as recommended by the epoxy manufacturer.
- 623.30.3.6 Epoxy Mixture. Mixing of epoxy components shall be in accordance with the manufacturer's recommendations. When mineral fillers are specified, the mineral fillers shall be inert and non-settling or readily dispersible. Material showing a permanent increase in viscosity or the settling of pigments that cannot be readily dispersed with a paddle shall be replaced at the contractor's expense. At least 95 percent of the filler shall pass the No. 200  $(75 \mu m)$  sieve.
- 623.30.3.7 Application. Application of epoxy shall be performed by the supplier or by a factory trained or licensed applicator with written approval from the manufacturer of the epoxy system.
- 623.30.3.7.1 The handling and mixing of epoxy shall be in accordance with the manufacturer's written recommendations. The overlay material shall not be placed when weather or surface conditions are such that the material cannot be properly handled, placed and cured within the specified requirements of traffic control, or when rain is forecasted within 24 hours of application.
- 623.30.3.7.2 The overlay shall consist of a thin prime coat and a two-course application of epoxy and aggregate. The first course shall be applied before the prime coat has gelled. The prime coat and first course shall not be placed as one application. Each of the two courses shall consist of a layer of epoxy covered with a layer of aggregate in sufficient quantity to completely cover the epoxy. The thickness of each course shall be approximately equal. The total thickness of the overlay shall be no less than 1/4 inch (7 mm).
- **623.30.3.7.3** The temperature of the bridge deck surface at the time of application shall be in accordance with the manufacturer's recommendation.
- 623.30.3.7.4 Dry aggregate shall be applied in such a manner as to cover the epoxy mixture completely within 5 minutes of application. The dry aggregate shall be placed in a manner such that the level of the epoxy mixture is not disturbed.
- 623.30.3.7.5 The first course shall be swept to remove loose aggregate prior to the second course application. Sweeping shall be done without removing embedded aggregate. First course applications which do not receive enough aggregate prior to gelling shall be removed and replaced. A second course applied with insufficient aggregate may be left in place, but additional applications shall be placed at the contractor's expense before opening to traffic.
- 623.30.3.7.6 The thickness of the overlay shall be verified to be at least 1/4-inch (7 mm), measured from the deck surface to the top of the resin. The contractor shall provide a minimum 1/2-inch (13 mm) diameter hole at a rate of at least one hole per 100 feet (30 m) of

traffic lane. Hole placement shall be at locations designated by the engineer. Thin areas shall be recoated and reverified at the contractor's expense.

- 623.30.3.7.7 When additional applications or recoating are required, the engineer may require additional adhesion strength tests by the contractor, at the contractor's expense, in accordance with ACI 503R to verify the contractor's procedure.
- **623.30.3.7.8** All adhesion strength test areas, thickness test holes or any debonded areas shall be repaired by filling with overlay material before final acceptance.
- **623.30.3.7.9** The epoxy concrete overlay shall be cured at least one hour, or until brooming or vacuuming can be performed without tearing or otherwise damaging the surface. No traffic or equipment shall be permitted on the overlay surface during the curing period.
- 623.30.3.7.10 After the curing period, all loose aggregate shall be removed by brooming or vacuuming and the next overlay course applied as specified in the contract documents.
- 623.30.3.7.11 The polymer mixture shall not be permitted to run into drains.
- 623.30.3.7.12 Unless otherwise specified, the epoxy concrete overlay courses shall be applied over the expansion joints and joint seals of the bridge deck. The expansion joints and joint seals shall be provided with a bond breaker. Prior to opening to traffic, the overlay shall be removed over each joint by removal of the bond breaker in accordance with the overlay manufacturer's recommendations.
- 623.30.3.7.13 Prior to opening a section to public or construction traffic, the overlay shall be allowed to cure in accordance with the manufacturer's recommendations. First course applications shall not be opened to traffic.
- 623.30.3.7.14 Damaged or debonded areas of an epoxy concrete overlay course shall be removed and repaired prior to acceptance. Repair shall consist of saw-cutting in rectangular sections to the top of the concrete deck surface and replacing the various courses in accordance with this specification at the contractor's expense.
- 623.30.4 Method of Measurement. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Where required, the area of polymer concrete overlay will be measured and computed to the nearest square yard (m²). This area will be measured longitudinally from end to end of bridge deck and transversely between the roadway face of curbs, excluding the area of the expansion device, if any. The revision or correction will be computed and added to or deducted from the contract quantity.
- 623.30.5 Basis of Payment. The accepted quantity of epoxy polymer concrete overlay will be paid for at the contract unit price.

### SECTION 623.40 POLYMER CONCRETE.

- **623.40.1** Description. This work shall consist of furnishing and placing polymer concrete as shown on the plans or as directed by the engineer.
- 623.40.2 Manufacturer Representation: The manufacturer's representative shall be present at the start of surface preparations and polymer concrete installation for at least one day. The contractor shall furnish the manufacturer's recommendations to the engineer as to the acceptability of all aspects of the operation. The contractor shall contact the manufacturer's representative at least two weeks prior to installation.

#### SECTION 1039,60 EPOXY POLYMER CONCRETE OVERLAY

1039.60.1 Scope. This specification covers an epoxy concrete overlay system consisting of an epoxy resin material and aggregate for use on bridge deck surfaces.

1039.60.2 Epoxy Resin Material. The infrared spectrum for each component of the epoxyresin material shall essentially match that of the standard infrared spectrum for the particular component as specified in AASHTO T 237, Sections 4 and 5. The epoxide equivalent for Component A shall not exceed 270. The mixed epoxy shall meet the following requirements:

Epoxy Resin Requirements			
Property	Specific Value		
Pot life, 75 F (24 C), minutes	10 - 55		
Tensile strength, 75 F (24 C), 7 Days, psi (MPa), min.	1500 (10.3)		
Tensile elongation, 75 F (24 C), percent, min.	20		
Water absorption, percent, max.	0.8		
Compressive strength, 4 hr., psi (MPa), min.	1000 (6.8)		
Compressive strength, 48 hr. wet, psi (MPa), min.	4000 (27.5)		
Ash content, percent, max	0.5		
Rotational Viscosity, 75 F (24 C), Spindle 3, 60 rpm, Poise	7 - 25		
Volatile Content, percent, max.	3.0		
Thermal Shear	No shearing, shrinkage, expansion or scaling.		

1039.60.2.1 Classes. Epoxy resin shall be formulated for use at specific temperatures as specified in ASTM C 881. The controlling temperature shall be that of the hardened concrete surface to which the overlay is applied. Where unusual curing rates are desired and upon the approval from the engineer, a class of epoxy may be used at a temperature other than that for which the epoxy is normally intended.

1039.60.2.2 Packaging. Containers shall be identified as "Component A--Contains Epoxy Resin" and "Component B--Contains Hardener" and shall show the type, class and mixing directions. Each container shall be marked with the name of the manufacturer, class, batch, or lot number, date of packaging, date of shelf life expiration, pigmentation, if any, manufacturer, and the quantity contained in pounds (kilograms) and gallons (liters).

1039.60.3 Aggregate for Epoxy Polymer Concrete Overlay. Aggregate shall be bauxite, crushed porphyry, aluminum oxide, flint chat or other similarly hard, durable, dry aggregates with less than 0.2 percent moisture. Aggregate shall be in accordance with the following gradation:

Aggregate Requirements		
Sieve Size	% Passing By Weight	
# 4 (4.75 mm)	100	
# 20 (850 μm)	0-5	
# 200 (75 µm)	0-1.0	

1039.60.3.1 Lead Content. Aggregate produced as a by-product from lead or zinc mining operations shall not have a total lead content greater than 4,500 ppm, as determined by EPA Method 3050A, "Acid Digestion of Sediments, Sludges and Soils (particle size reduced to 1 mm or less)". Suppliers of this aggregate shall provide certification to the engineer for each shipment that the total lead content of the aggregate does not exceed this value, and attach a typical test report from the same source no older than 12 months prior to the shipment.

1039.60.3.2 Aggregate Recommendation. For each contract, the epoxy supplier shall supply a letter to the engineer specifically recommending the use of a designated aggregate and source, which has been previously approved by Construction and Materials.

1039.60.4 Overlay System. The overlay system shall not exhibit shearing, shrinkage, expansion or scaling.

1039.60.5 Test Methods. Tests will be performed in accordance with the following methods:

Test Methods			
Rotational Viscosity	ASTM D 2393 Model LVT Brookfield viscometer		
Epoxy equivalent	MoDOT Test Method TM 73.		
Volatile content <sup>a</sup>	ASTM D 1259, Method B, for mixed system		
Filler content	MoDOT Test Method TM 73		
Ash content	ASTM D 482		
Pot life	AASHTO T 237		
Tensile strength	ASTM D 638		
Compressive strength	ASTM C 881		
Water absorption	ASTM D 570		
Thermal Shear	MoDOT Test Method TM 72		

<sup>a</sup>Sample cured 4 days at room temperature and weighed on a previously weighed metal foil.

1039.60.6 Manufacturer and Brand Name Approval. Prior to approval and use of this material, the manufacturer shall submit to Construction and Materials a certified test report showing specific test results in accordance with all requirements of this specification. The certified test report shall include the manufacturer's name, brand name of material, lot tested, date of manufacture, ratio of components by volume and system tested. In addition, the manufacturer shall submit to Construction and Materials a sample representing the system for laboratory testing accompanied by a technical data sheet, an MSDS and any special installation instructions relative to the system being submitted. Upon approval of the certified test report and satisfactory results of tests performed on the sample submitted, the brand name and manufacturer will be placed on a qualified list of epoxy resin material for polymer concrete overlay. New certified test results and samples shall be submitted any time the manufacturing process or the material formulation is changed and may be required when random sampling and testing of material offered for use indicates non-conformity with any of the requirements herein specified.

1039.60.7 Product History. The overlay system shall have a proven record of a minimum of two years on similar bridge decks within the United States. A list including the location, the name of the agency involved with the project, and a name and phone number of a contact person with that agency, shall be provided for each location used as evidence of satisfactory use.

1039.60.8 Acceptance. The manufacturer shall furnish certification to the engineer at the destination that the material supplied is in accordance with all requirements specified and stating that the material supplied is the same system and is identically formulated to the material tested for manufacturer and brand name approval. Acceptance will be based on certification and testing.

# SECTION 1039,70 POLYMER CONCRETE

1039.70.1 Scope. This specification covers polymer concrete consisting of a fast setting epoxy based solid that may contain aggregate for use at bridge expansion joints.



#### **SECTION 616**

### TEMPORARY TRAFFIC CONTROL

616.1 Description. This work shall consist of furnishing, installing, operating, maintaining, cleaning, relocating and removing temporary traffic control devices and equipment, and the removal and relocation or covering and uncovering of existing signs and other traffic control devices in accordance with the contract documents or as directed by the engineer. For purposes of this specification, the work zone will be defined as the area between the first and last temporary traffic control device as shown on the plans for the work being performed.

616.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section	
Temporary Traffic Control Devices	1063	

### 616.3 Safety Requirements.

616.3.1 All workers within highway right of way who are exposed to traffic or construction equipment shall wear high-visibility safety apparel meeting Class 2 or Class 3 requirements of ANSI/ISEA 107-2004 publication entitled, "American National Standard for High-Visibility Safety Apparel and Headwear".

616.3.2 All traffic control devices shall be in accordance with the MUTCD and any applicable safety and design codes.

616.3.3 The contractor shall furnish a manufacturer's certification of crashworthiness, per NCHRP 350 Evaluation Criteria, for FHWA Category 1 traffic control devices and appurtenances. The contractor shall furnish the FHWA acceptance letter for FHWA Category 2 and Category 3 traffic control devices and appurtenances. The FHWA acceptance letter shall indicate that the device and appurtenance complies with the crash test requirements of NCHRP 350, Test Level 3 (TL-3). Regardless whether the device meets NCHRP 350 criteria, the engineer reserves the right of final approval. Installation of a device prior to the engineer's approval will be at the contractor's risk.

# 616.3.4 The contractor shall:

- (a) Designate a trained person at the project level who has the primary responsibility, with sufficient authority, for implementing the traffic management plan and other safety and mobility aspects of the project. The name of that person, proof they successfully completed MoDOT's Advanced Work Zone course, ATSSA's Traffic Control Supervisor course or an approved equivalent training course, and a 24-hour contact number for that person shall be provided to the engineer at the pre-construction meeting. Re-certification will be required as dictated by the organization providing the training.
- (b) Ensure all contractor personnel are trained in traffic control to a level commensurate with their responsibilities.

- (c) Advise the engineer, as required, at least two working days before any work requiring a lane closure begins and 14 calendar days prior to the imposition of height, width and weight restrictions.
- (d) Perform quality control of work zones to promote consistency and ensure compliance with contract documents, policies and guidelines.

### 616.4 Construction Requirements.

- 616.4.1 Performance and operational aspects of the devices shall be in accordance with the latest editions of the MUTCD and the Missouri *Quality Standards for Temporary Traffic Control Devices*.
- 616.4.1.1 All traffic control devices shall be removed as soon as practical when the devices are no longer needed. When work is suspended for short periods of time, traffic control devices that are no longer appropriate shall be turned away from traffic, removed or covered. All temporary traffic control devices shall be removed after the completion of construction and shall remain the property of the contractor unless specified otherwise. All permanent traffic control devices that are in conflict with temporary traffic control devices shall be covered or removed as shown on the plans or as directed by the engineer. Upon completion of the work, all permanent traffic control devices to remain in place shall be restored to original condition.
- 616.4.1.2 All sign covers shall meet the requirements of the MoDOT Quality Standards for Temporary Traffic Control Devices.
- 616.4.1.3 All permanent traffic control devices relocated on a temporary basis shall be moved in the timeframe designated by the engineer, and shall remain visible to the traveling public during all stages of construction. The contractor shall place temporarily relocated permanent traffic control devices in the final location when construction is complete. Damaged devices shall be replaced by the contractor at the contractor's expense.
- 616.4.2 The contract will indicate the minimum requirements for traffic control. With the engineer's approval, the contractor may add to the traffic control plan any temporary traffic control devices or services the contractor considers necessary to adequately protect the public and the work. Device quantities may be adjusted accordingly.
- 616.4.2.1 Signs and sign quantities for blasting areas will not be included in the contract traffic control plan. The contractor will be responsible for furnishing, installing, maintaining and removing blasting zone signs in accordance with the MUTCD, at the contractor's expense. Placement of blasting zone signs will be subject to approval from the engineer.

- 616.4.2.2 All changes to the traffic control plan resulting from contractor staging revisions, including proposed total road closures for the contractor's convenience, shall be submitted in writing to the engineer for review and acceptance prior to implementation. Device quantities may be adjusted accordingly.
- 616.4.2.3 If the engineer determines the need for additional traffic control devices not included in the traffic control plan, the contractor will be notified in writing to provide the additional devices. Reimbursement for authorized changes to the traffic control plan will be made in accordance with Sec 104.3, unless covered by contract unit prices.
- 616.4.2.4 The contractor shall monitor traffic flow through the project and verify that all traffic control devices are in place and functioning properly during both daytime and nighttime conditions, as applicable. If the contractor determines that a deficiency in any traffic control device exists, the contractor shall take corrective action. No additional payment will be made for the corrective action.
- 616.4.2.5 As soon as possible after observing a traffic control deficiency, the engineer will report the deficiency to the contractor, either verbally or in writing. After receiving notification, if the contractor does not make corrections within an agreed upon timeline, order records or suspension of the work may occur. Regardless of the severity of the deficiency, corrections shall be made as soon as possible to maintain a quality work zone.
- 616.4.2.5.1 The severity of a deficiency will be categorized as follows:
  - (a) Category 1 Presents an immediate danger to the traveling public or workers and needs to be addressed immediately.
  - (b) Category 2—The situation doesn't pose an immediate threat to either the public or the workers, but can impact the proper functioning of the work zone.
  - (c) Category 3 The situation doesn't impact the functioning of the work zone but is more of a maintenance or aesthetic issue.
- 616.4.2.5.2 When the engineer determines that the contractor has not made a good faith effort in correcting a deficiency as agreed upon in Sec 616.4.2.5, an order record will be issued and the contractor will be notified of the following timelines to correct the deficiency.
  - (a) A Category I deficiency shall be corrected within one hour.
  - (b) A Category 2 deficiency shall be corrected within 24 hours.
  - (c) A Category 3 deficiency shall be corrected within 96 hours.
- 616.4.2.5.3 When the engineer determines the contractor has not made a good faith effort in complying with an order record issued in accordance with Sec 616.4.2.5.2, the following action may be taken:
  - (a) A second order record will be issued.

- (b) The engineer may find the contractor in violation of the contract in accordance with Sec 105.
- 616.4.2.5.4 For reoccurring deficiencies of similar nature within the contractor's control, the engineer may issue order records in accordance with Sec 616.4.2.5.3, bypassing Sec 616.4.2.5.2 requirements.
- 616.4.2.6 The contractor shall provide written notice to the engineer of any pedestrian or vehicular accident when physical evidence or other information suggests an accident has occurred in the work zone. The contractor shall obtain and provide to the engineer copies of law enforcement accident reports for any accidents in the work zone.
- 616.4.3 Each flagger, automated flagger assistance devices (AFAD) operator, portable flagger device (PDF) operator and pilot vehicle operator shall maintain a valid flagger certification card that certifies the individual has been trained in the principles of flagging in accordance with the MUTCD. Certifications will not be required in emergency situations that arise due to actions beyond the contractor's control when flagging is necessary to maintain safe traffic control on a temporary basis. All flagging, AFAD, PFD and pilot vehicle operations shall be in accordance with the MUTCD. Flaggers and pilot vehicles shall be provided as shown on the plans or as approved or directed by the engineer. When not specified in the plans, the contractor may use a Type B (Red/Yellow Lens) AFAD PFD or pilot vehicle to supplement the flagging operation upon approval from the engineer. When two-way traffic is maintained over a single lane, each flagger, AFAD operator, if used in tandom, and pilot vehicle operator involved in the traffic flagging operation shall be equipped with a portable, two-way, communication system approved by the engineer. When the AFED or PFD are not in use they shall be removed from the roadside.
- 616.4.4 Crossovers for hauling material will be permitted only at locations indicated in the traffic control plan or as authorized by the engineer. Modifications to specified locations shall be in accordance with applicable portions of Sec 104. Crossovers shall be signed in accordance with the traffic control plan. When the project has been completed, temporary crossovers shall be removed and the area restored to original condition. Existing crossovers shall be restored to original condition, including surface material.

### 616.5 Lighting Requirements.

- 616.5.1 All construction-related vehicles and equipment, except for haul trucks within paving operations, shall be equipped with a USDOT-approved warning light. Lights shall be amber in output, mounted such that the lights are visible to traffic from 360 degrees and activated while in the work zone.
- 616.5.2 Work zone lighting shall be provided between dusk and dawn as specified in Secs 616.5.2.1 and 616.5.2.2. Lighting systems shall be positioned such that the lighting systems do not cause glare or hot spots, i.e. concentrated areas of high lighting intensity when compared to the average, for motorists, spillover to adjacent properties or become safety concerns. When work zone lighting is required, a lighting plan shall be submitted to the engineer for review 14 days prior to the start of operations. The lighting plan shall show the areas to be illuminated, the type and layout of the lighting systems and calculations of average maintained footcandles (lux).
- 616.5.2.1 Work area lighting shall be provided in areas where construction equipment and labor are active. Lighting shall provide a minimum maintained intensity of 5 footcandles (54 lux).

- 616.5.2.2 Overhead lighting shall be provided for flaggers and other specified locations shown on the plans. Lighting in these areas shall provide a minimum maintained intensity of 0.6 footcandles (6.5 lux).
- 616.6 Flashing Arrow Panel. The contractor shall deploy, operate and maintain flashing arrow panels as specified on the plans for the duration of the project, in accordance with the manufacturer's recommendations, at the contractor's expense. A minimum vertical clearance of 7 feet (2.1 m) shall be maintained from the edge of pavement to the bottom of the flashing arrow panel.
- 616.6.1 When not in use, trailer-mounted flashing arrow panels shall be stored in accordance with Sec 107.5.
- 616.6.2 Control programs shall be as follows:
  - (a) Caution: Flash the two highest and two lowest lamps on panel simultaneously.
- (b) Left or Right Arrow: Flash five lamps in the arrowhead and five lamps in the horizontal shank simultaneously.
- (c) Double Arrow: Flash five lamps in both the left and right arrowheads and three lamps in the horizontal shank simultaneously.
- 616.7 Changeable Message Signs. The contractor shall place the changeable message sign (CMS) at the location shown on the plans or as directed by the engineer. The CMS shall not be located in the median.
- **616.7.1** The contractor shall deploy, operate and maintain the CMS as specified in the traffic control plan and in accordance with the manufacturer's recommendations for the duration of the project at the contractor's expense. The contractor shall program the CMS as directed by the engineer.
- 616.7.2 When the CMS is not in use, the message board shall be turned away from traffic. When not required for longer than a 24-hour period, the CMS shall be stored in accordance with Sec 107.5.
- 616.8 Work Zone Traffic Signals. Work Zone Traffic Signals (WZTS) provide one-lane, two-way temporary traffic control through the use of a temporary traffic signal or a portable traffic signal programmed for two-phase operation. WZTS shall be in accordance with the provisions of this section. Unless otherwise shown on the plans, the contractor may choose either method to fulfill the WZTS requirement.
- 616.8.1 The contractor shall notify the engineer at least 48 hours prior to the work zone traffic signal installation. After installation, the contractor shall receive approval from the engineer prior to activating the WZTS system. The contractor shall provide a service technician to be available for day, night and weekend trouble calls as required under test period requirements in Sec 902. The contractor shall furnish the telephone number or other contact information where the technician can be reached.
- 616.8.1.1 The contractor shall operate and maintain the WZTS, at the contractor's expense, as specified in the traffic control plan until two-way traffic is restored.
- 616.8.1.2 When the WZTS is not in use, the signal heads shall be covered to the satisfaction of the engineer.

- 616.8.1.3 Adequate traffic control, including flaggers, shall be provided at the contractor's expense during the startup and shutdown of the WZTS installation. If the WZTS installation becomes inoperable due to alterations, malfunctions or periods of shutdown for required maintenance when one-way traffic control is required, the contractor shall provide adequate traffic control, including flaggers, at the contractor's expense.
- 616.8.1.4 All signal timing and programming shall be provided by the contractor and furnished to the engineer for approval prior to use. The contractor shall ensure proper signal timing is provided for the duration of the project. The contractor shall provide the locations of the vehicle detection zones.
- 616.8.1.5 The WZTS and lighting system shall be removed after two-way traffic has resumed or as directed by the engineer. All equipment shall remain the property of the contractor.
- 616.8.1.6 Measurement of WZTS system, including lighting and traffic signals at both ends of a one-lane, two-way section, will be made per each.
- 616.8.2 Temporary Traffic Signals. Temporary traffic signals and lighting shall be in accordance with Sec 902.3.
- 616.8.3 Portable Traffic Signals. Portable traffic signals shall be in accordance with Sec 1063. The contractor shall place the portable traffic signal (PTS) units a minimum of 6 feet (2 m) beyond the edge of shoulder at the location shown on the plans or as directed by the engineer. Each unit shall be level to the satisfaction of the engineer. Each PTS shall be delineated with a minimum of five non-metallic drum-like channelizers. The PTS shall not be located in the median.
- 616.8.3.1 When not required for a longer than a 24-hour period, the PTS shall be stored in accordance with Sec 107.5.
- 616.8.3.2 The contractor shall deploy, operate and maintain the PTS in accordance with the manufacturer's recommendations. The contractor shall provide two copies of the operating manual to the engineer.
- 616.8.3.3 Overhead lighting with an average maintained intensity of 0.6 footcandles (6.5 hux) shall be provided and maintained at each PTS location as authorized by the engineer.
- 616.9 Portable Flagger Device. Portable flagger devices (PFD) shall be installed on each side of roadway per direction and in accordance with Sec 1063.9.
- 616.10 Method of Measurement. Measurement for relocation of post-mounted signs will be made to the nearest square foot (m<sup>2</sup>) of sign area.
- 616.11 Basis of Payment. Temporary traffic control devices specified in the traffic control plan or authorized by the engineer will be paid for at the contract unit price for each of the pay items included in the contract. No direct payment will be made for the following:
- (a) Incidental items necessary to complete the work, unless specifically provided as a pay item in the contract.
- (b) Installing, operating, maintaining, cleaning, repairing, removing or replacing traffic control devices.
  - (c) Covering and uncovering existing signs and other traffic control devices.

- (d) Relocating temporary traffic control devices, including permanent traffic control devices temporarily relocated, unless specifically included as a pay item in the contract.
  - (e) Worker apparel.
  - (f) Flaggers, AFADs, PFDs, pilot vehicles, and appurtenances at flagging stations.
- (g) Furnishing, installing, operating, maintaining and removing construction-related vehicle and equipment lighting.
- (h) Construction and removal of temporary equipment crossovers, including restoring pre-existing crossovers.

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